strengths would depend on the spacing of the coils, and the spacing could be varied in different electromagnetic arrays.

[0138] Embodiments of the invention are directed to devices and methods for detecting the presence of an analyte in a sample. According to one embodiment, the device comprises a fluidic network comprising a plurality of fluidic zones, each fluidic zone being connected to the adjacent zone by a diffusion barrier, and an integrated circuitry component. According to another embodiment, the invention encompasses a device comprising a substrate containing a plurality of fluidic zones, each fluidic zone being connected to the adjacent fluidic zone by a diffusion barrier, wherein each fluidic zone comprises a fluid, and wherein one or more fluidic zones comprises a magnetic particle. In one aspect, the device is adapted to permit transport of the magnetic particle from one fluidic zone to an adjacent fluidic zone substantially without moving the fluid between the fluidic zones.

[0139] An array of magnetic microcoils can be functionally coupled to the fluidic network, which is programmably activatable to generate a magnetic field in proximity to each microcoil. The microcoil array can be integrated into the network, or it can be located near the fluidic zones of the device, so that at least one microcoil is placed suitably for generating a magnetic field in at least a portion of a fluidic zone. A detection element is also functionally coupled to the fluidic network; it can be integrated into the network or located in proximity to the network. Generally, it is situated so that whether integrated or temporarily coupled, it detects optical or electrical signals from one or more of the fluidic zones. A vibration element can also be functionally coupled to the network; it can be integrated into the network or located in proximity to one or more fluidic zones. Typically, when activated, the vibration element is so situated that it will achieve the desired effect of shaking or agitating fluid within one or more fluidic zones of the device.

[0140] Certain embodiments of the invention are self-contained such that substantially no liquid flows between the fluidic zones, thereby eliminating the need for flow controllers. In such embodiments, the magnetic particles and any molecules bound to the magnetic particles are moved through the liquid contained within the fluidic zones by activating the magnetic microcoils, and are not moved by the flow of the liquid. Typically in these embodiments, the fluid is present in the fluidic zones to act as a suspending agent. Other embodiments of the invention comprise a flow controller for coordinating liquid flow through the fluidic zones of the device. In such embodiments, the magnetic particles and any molecules bound to the magnetic particles are moved through the fluidic zones by activating the magnetic microcoils and/or also can be moved by activating the flow controller to move the liquid itself. The flow controller is functionally coupled to the network: it can be integrated into the network or external to the network.

[0141] The fluidic zones of the device typically comprise a reservoir, channel, groove, opening, or conduit in the substrate of the fluidic device, which is configured for containing a liquid and optionally for containing reagents. In one embodiment, the plurality of fluidic zones comprises a sample zone, a cleaning zone and/or a detection zone. In a further embodiment, it comprises more than one sample zone, cleaning zone, and/or detection zone. It can comprise additional fluidic zones for storing reagents, which can be branches of any of the aforementioned zones. In one embodiment, multiple fluidic zones are contained in parallel within the same device, thus allowing for analysis of multiple samples or multiple analytes in parallel. Each fluidic zone is separated from the adjacent fluidic zone by a diffusion bamrer.

[0142] Diffusion barriers connect the fluidic zones of the device. They are designed and situated to minimize diffusion or convectance of the contents of one fluidic zone to the next fluidic zone, such that the majority of the contents that move from one zone to the next fluidic zone are moved by directed fluidic flow and/or by activating the magnetic microcoil array. In certain embodiments, the diffusion barrier is a fluidic channel that is designed to alter the path of the fluidic zone. In other embodiments, the diffusion barrier is a thermally-sensitive barrier. Hydrophilic fluid or liquid can be contained in a shape of droplets surrounded by hydrophobic liquid such as silicone oils to form strong diffusion barriers through hydrophilic-hydrophobic interactions so that droplets can be separated and transported without mixing with other fluids as demonstrated in J. Micromech. Microeng. (2006) 16:1875 and Sensors and Actuators B (2006) 113:563. A diffusion barrier can be accomplished by "particle trapping and transport" through DEP (dielectrophoresis) as demonstrated in Biophysical Journal (1998) 74:1024 and Sensors and Actuators A 121 (2005) 59.

[0143] The detection element is situated in proximity to the detection zone. The detection element can be an optical detection element or an electrical detection element. In certain embodiments, the optical detection element is selected from a Raman detector, a photon multiplier tube, a fluorescent reader, or an electrochemical sensor and the electrical detection element is selected from a FET element, a capacity detection element, a current sensor, and a charge sensor. Typically, the detection of the binding complex or the signal analyte complex indicates the presence of the analyte.

[0144] In further embodiments, the detection zone comprises a reaction substrate that interacts with a catalytic element to form a fluorogenic, chemiluminescent, or chromogenic product. Non-limiting examples of reaction substrates include Lumigen APS-5, Lumigen TMA-6, Lumigen PS-atto, Lumigen PS-3, H_2O_2 with an oxidizable compound, Amplex Red, 3,5,3',5'-tetramethylbenzidine (TMB), glucose, O_2, ATP, Mg^{2+}, luciferin, inoluciferin, quinolinyl, coelentrazine, aldehyde, $FMNH_2$, and analogs and combinations thereof.

[0145] Typically, if the detection zone comprises a reaction substrate, the magnetic particle and/or the signal particle comprises a catalytic element that serves as an agent to cause a chemical reaction to occur in the reaction substrate, where the reaction product is detectable by the detection element. In certain non-limiting embodiments, the catalytic element is selected from the group consisting of alkaline phosphatase, horseradish peroxidase, glucose oxidase, luciferase (from firefly, Renilla, bacteria, or other sources) or analogs or combinations thereof. The catalytic element can be covalently or non-covalently conjugated to the signal particle through a functionalized polymer. The fluidic zones of the device generally contain an appropriate buffer to permit the reaction to occur.

[0146] The sample zone of the device comprises a magnetic particle selected from the group consisting of a magnetic affinity complex and a coded magnetic affinity complex. Magnetic particles may also be present within other fluidic zones of the device. The microcoils are activated in such a manner as to move the magnetic particles within the device.